Transmission Options
Importing Renewable Resources into California

2005 Integrated Energy Policy Report
Workshop on Renewable Resources and Transmission
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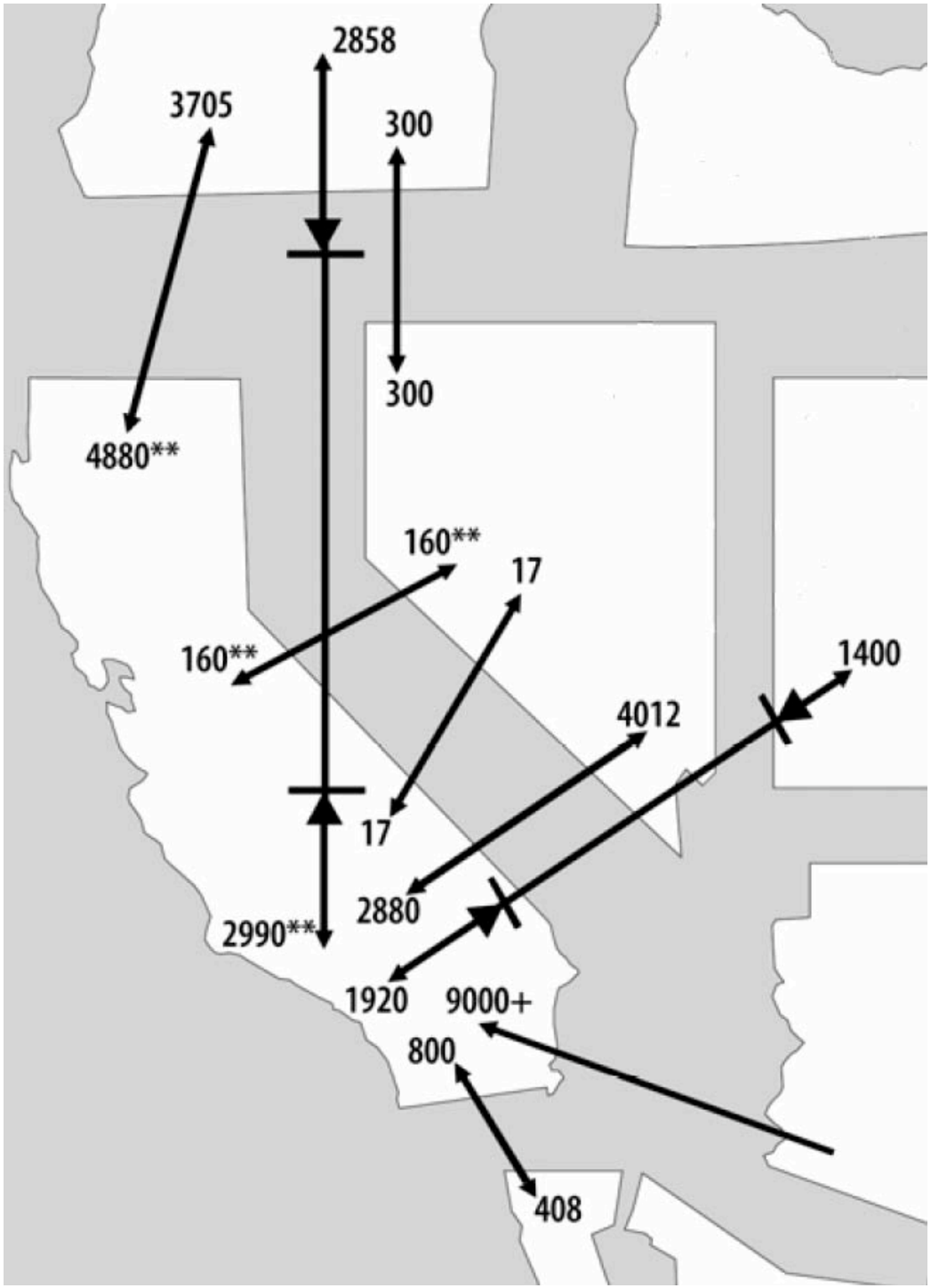
ELECTRANIX

Western AREA POWER ADMINISTRATION

Winfield Enterprise LLC



Existing Interconnections into California

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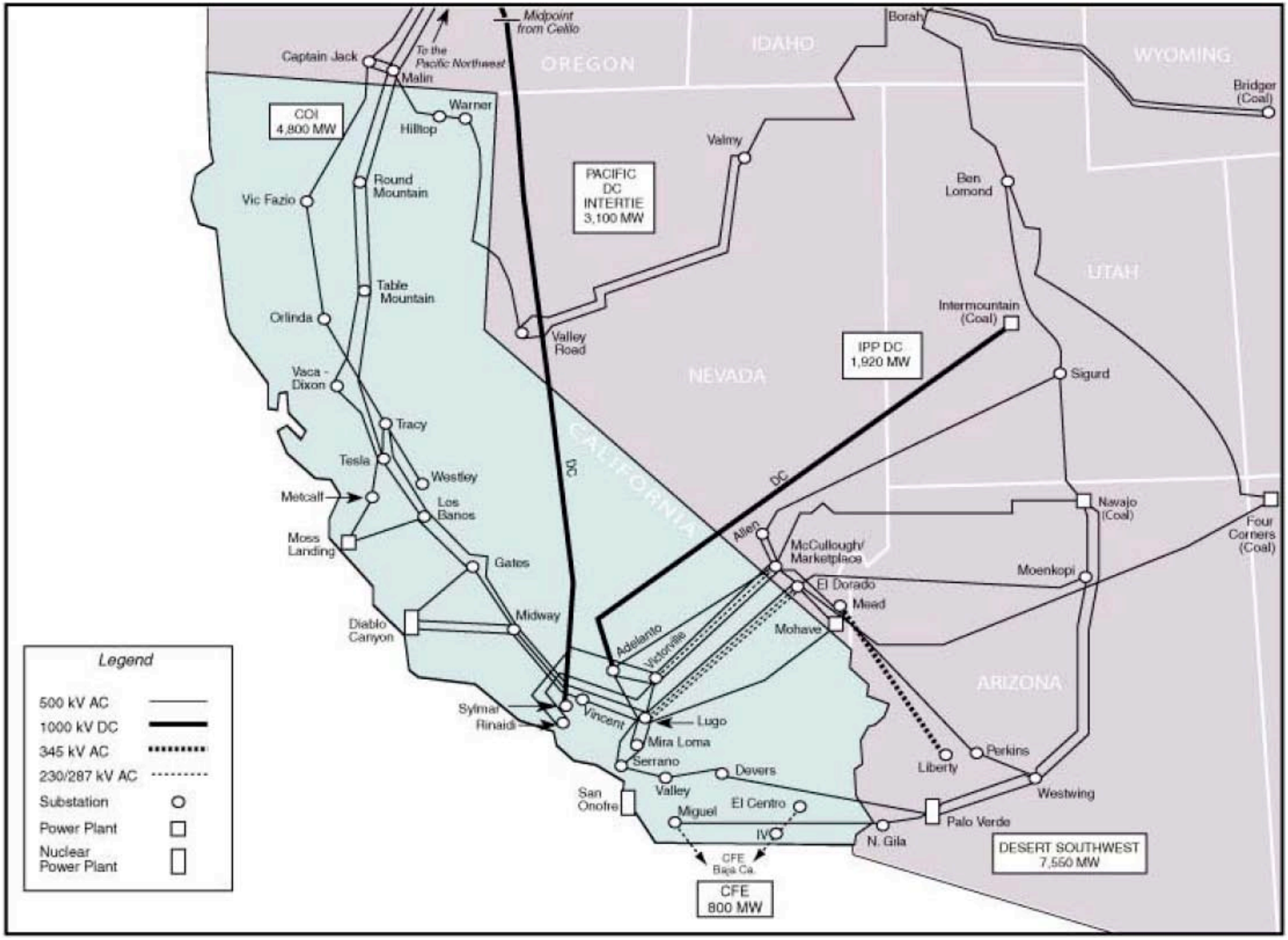


To increase Interconnection Capacity into California

In the short term:

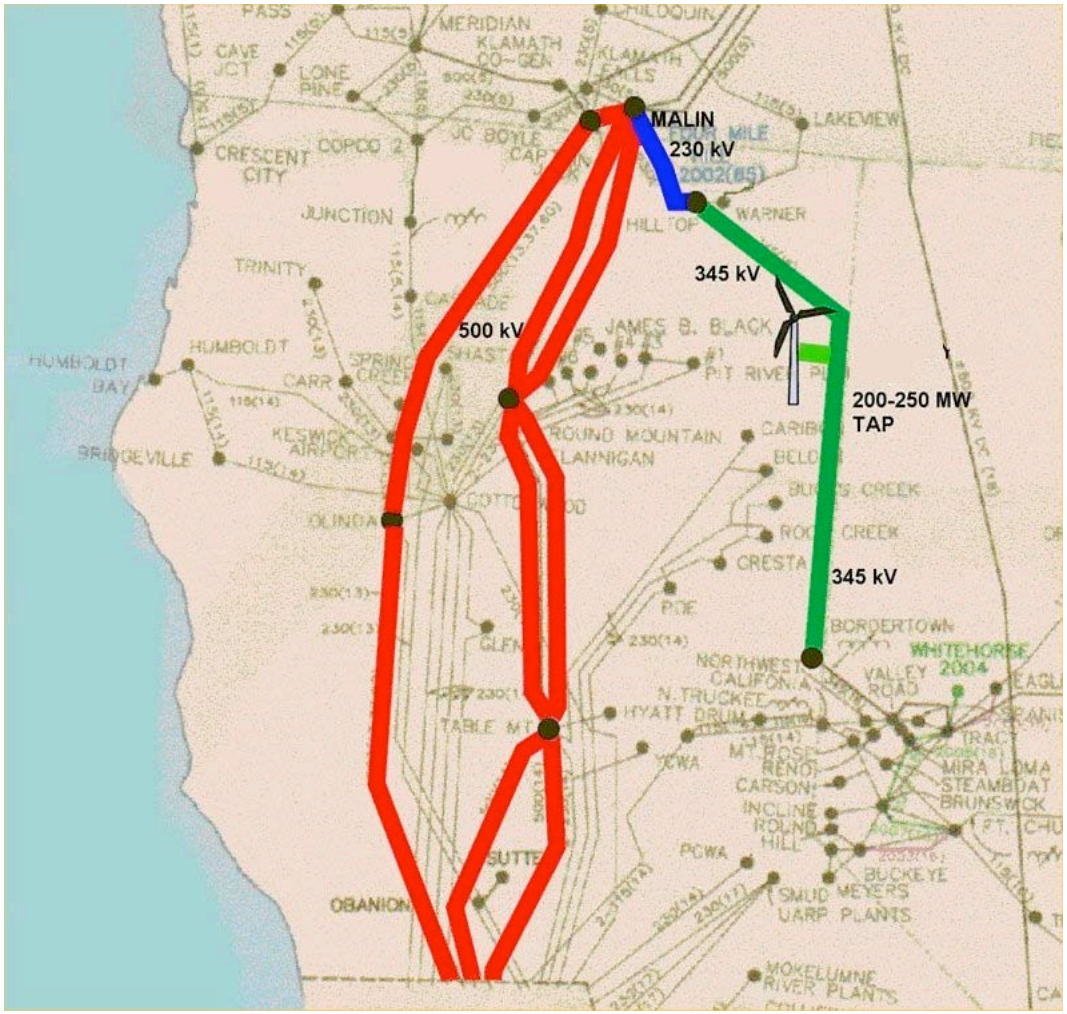
- Interconnect to existing transmission if capacity available

Add capacity to existing transmission by:

- Re-conductor (increase current)
- Re-insulate (increase voltage)
- Convert to dc transmission
- Add equipment to reduce system constraints

No new right-of-way required, so that permitting should be faster

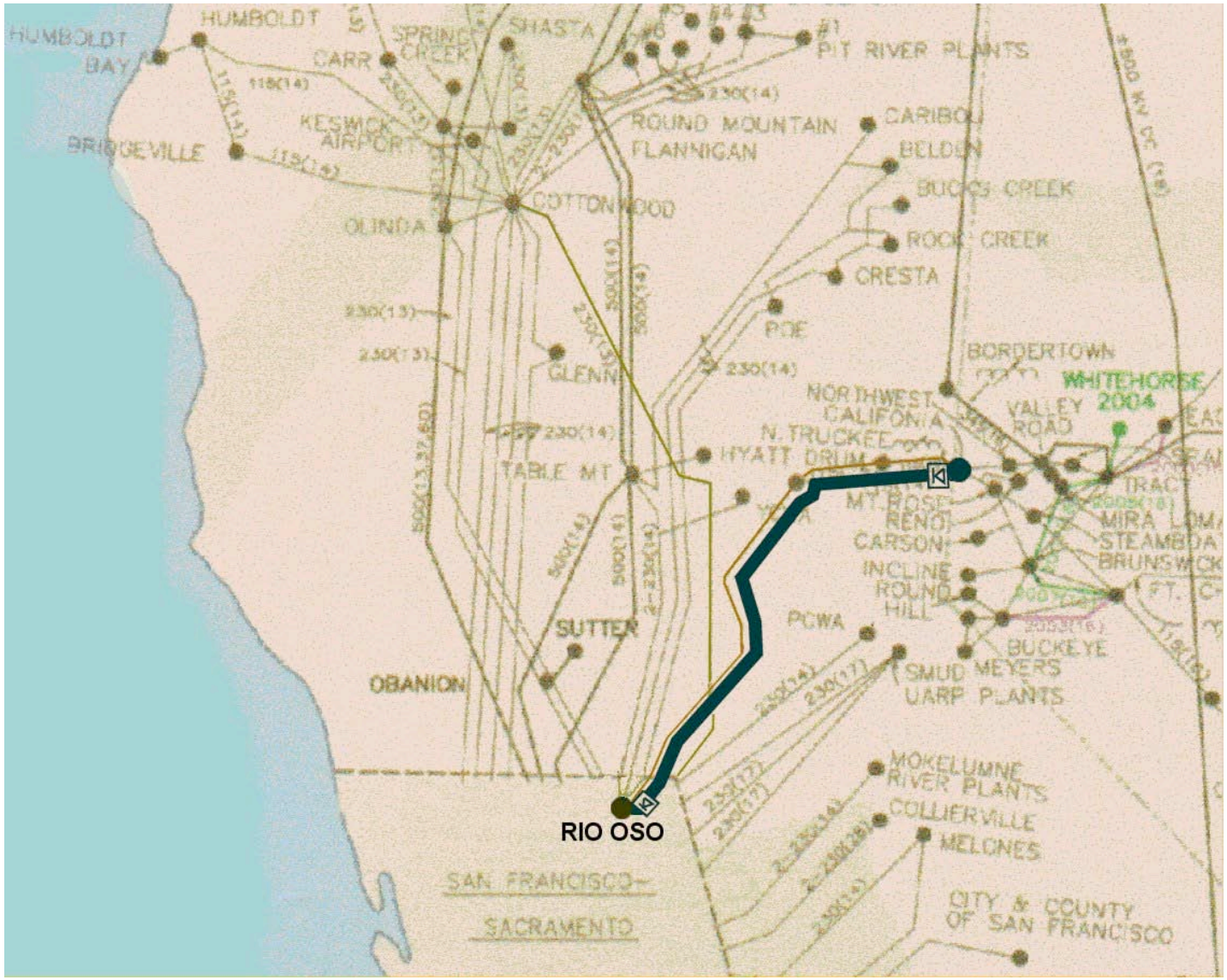
Short term example where upgrades could be applied Tap NE California Wind Farm to Bordertown – Alturas 345 kV transmission line



250 MW to circulate into Northern California subject to system constraints and available capacity

Short term example where upgrades could be applied

Consider the 115/120 kV transmission lines through Donner Pass



Short term example where upgrades could be applied 115/120 kV transmission lines through Donner Pass 160 MW total for both circuits today

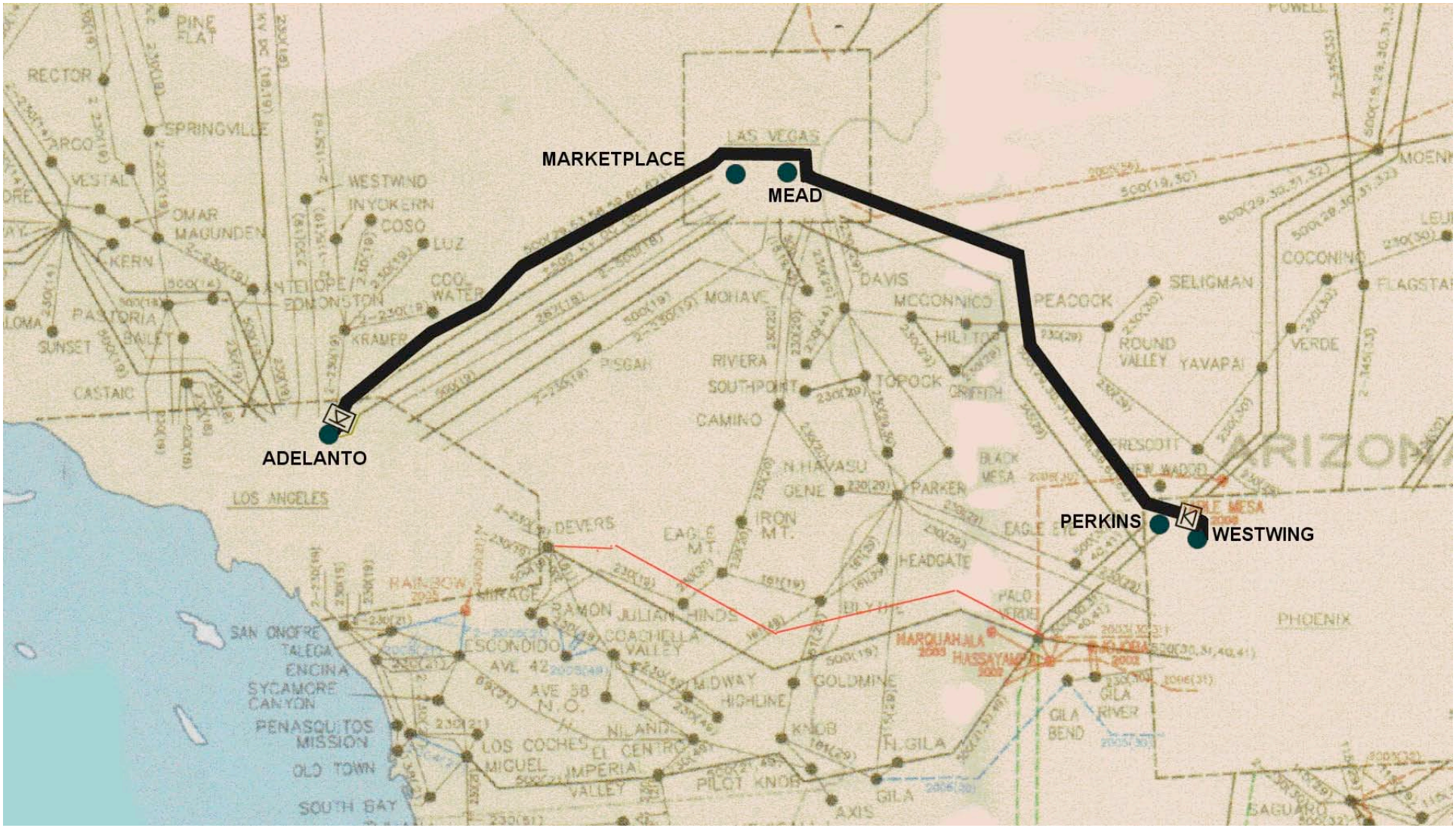
- **Option 1 - Reconductor**. Using Aluminum Conductor Composite Core conductor of same weight as existing conductors. 100% increase in capacity

- **Option 2 - Re-Insulate to 150 kV DC**. The ac voltage could be raised perhaps from 115 kV to 150 kV. The new conductor with less sag will facilitate this. 30% increase in capacity

- **Option 3 – Convert one circuit to dc**. 300% increase in capacity

The above capacity increases are subject to limits by system constraints

Short term example where upgrade could be applied Convert to dc transmission the Westwing – Mead – Adelanto 500 kV Line – 100% increase in capacity.



To increase Interconnection Capacity into California

Selected near term upgrades

Description	**Increased Capacity (MW)**	**Capital Cost M_{2005}$**	**$/kW**
Tap to the Bordertown – Alturas 345 kV line in NE California	250	13	52
Upgrade Westwing – Mead – Adelanto 500 kV ac line to dc	1200	257	214
Upgrade the 115/120 kV transmission lines through Donner Pass	470	289	615

To increase Interconnection Capacity into California

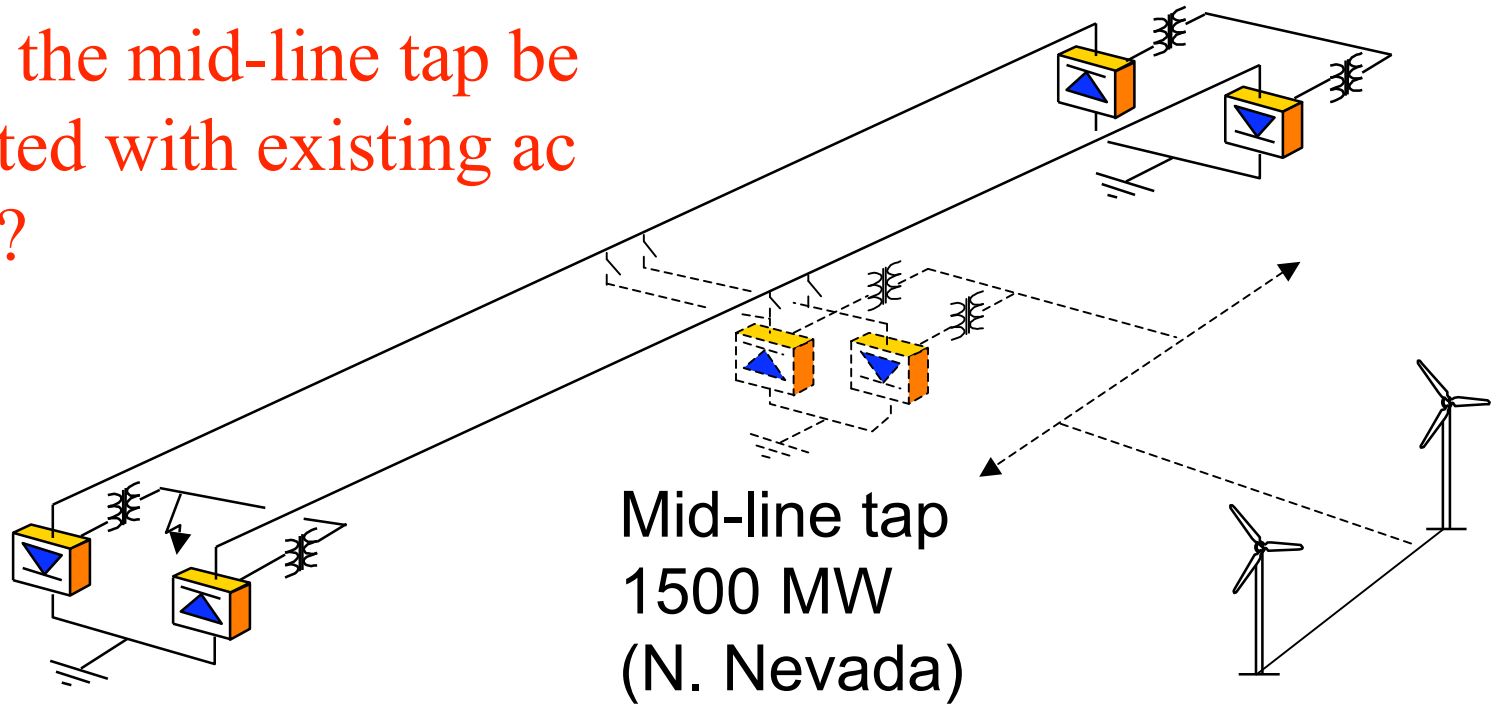
In the long term new transmission can be planned, requiring

- Right-of-way
- Permitting
- Financing
- Adequate transmission infrastructure at the sending end and receiving end to reduce system constraints

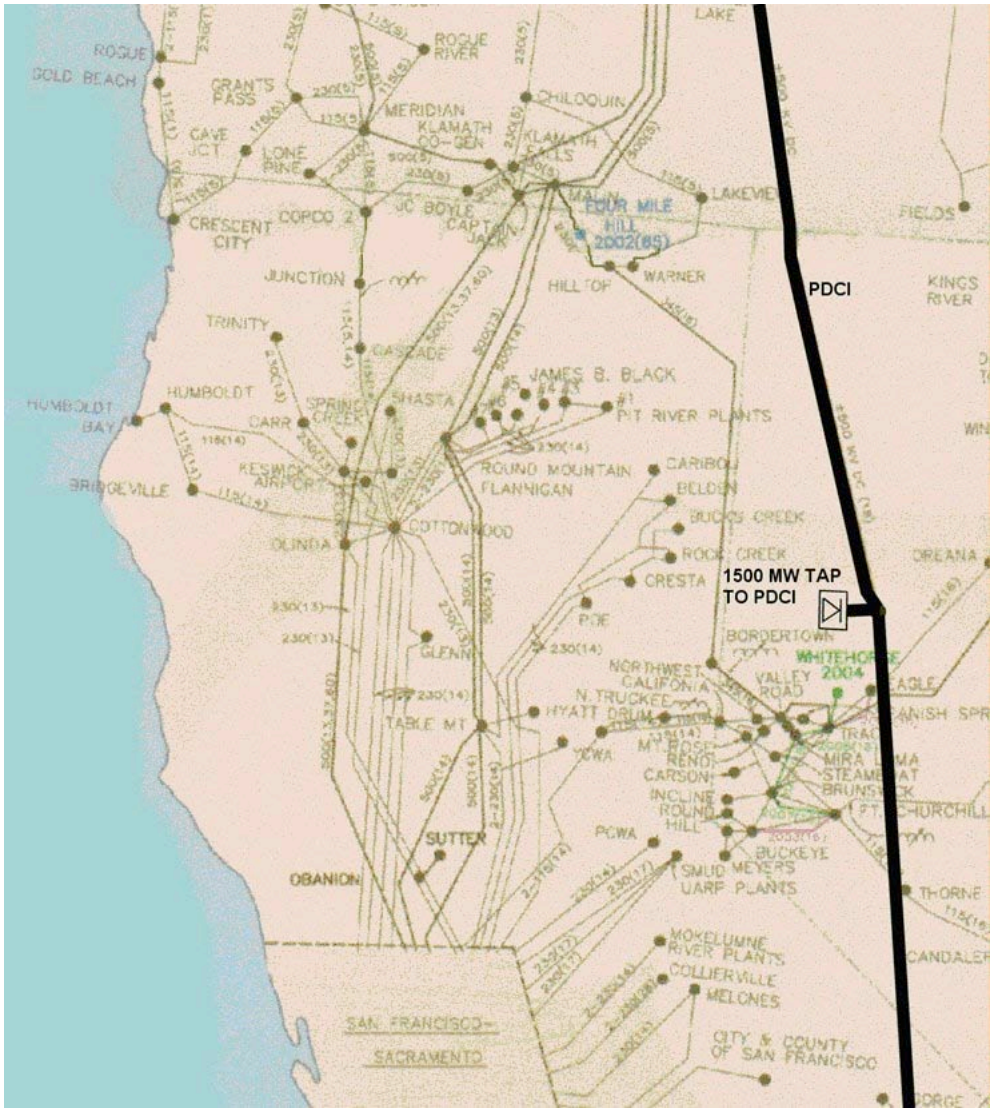
Feasibility for Interconnecting to the Pacific HVDC Intertie

Considerations:

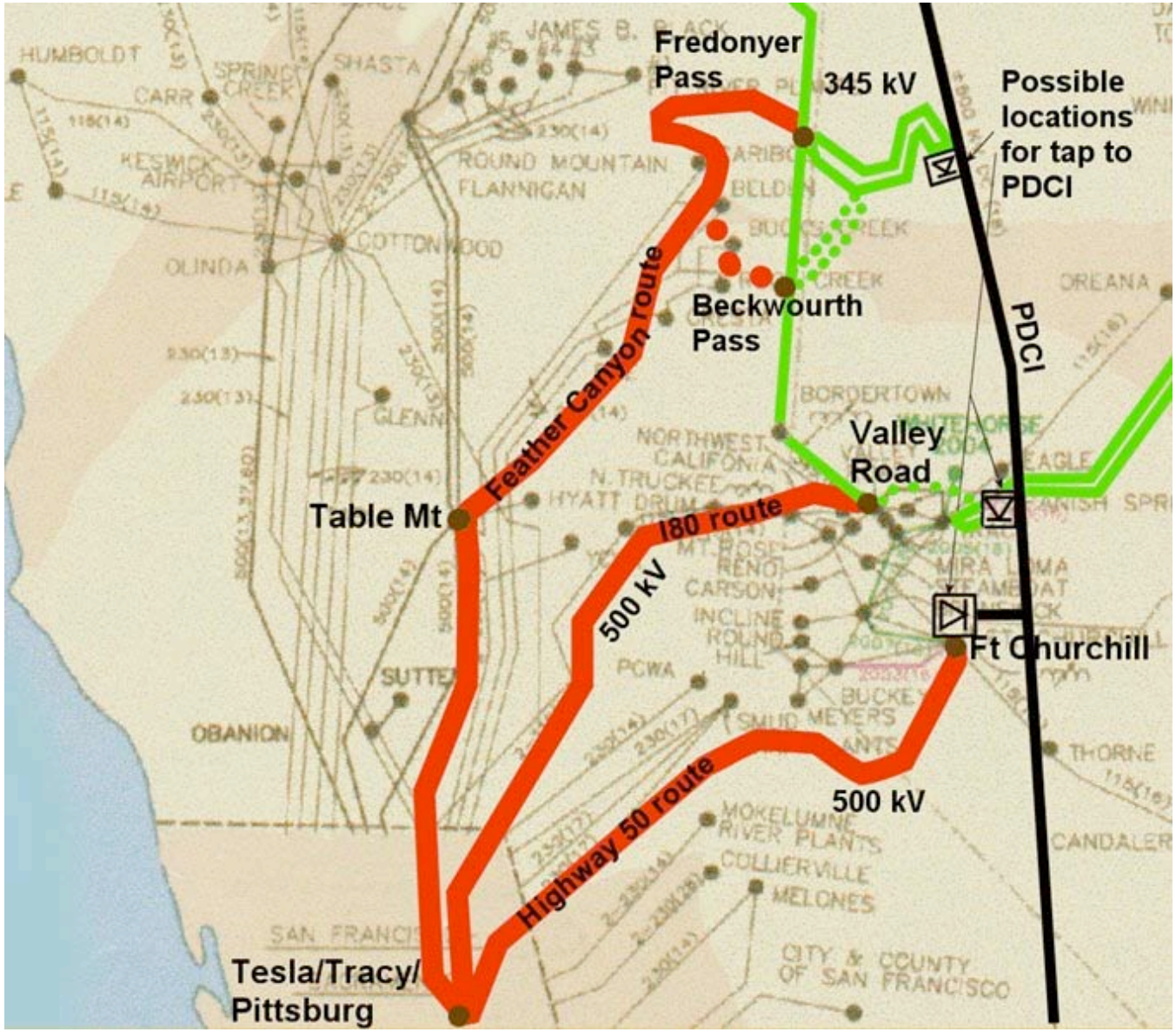
- Capacity available
- Should the mid-line tap be integrated with existing ac system?



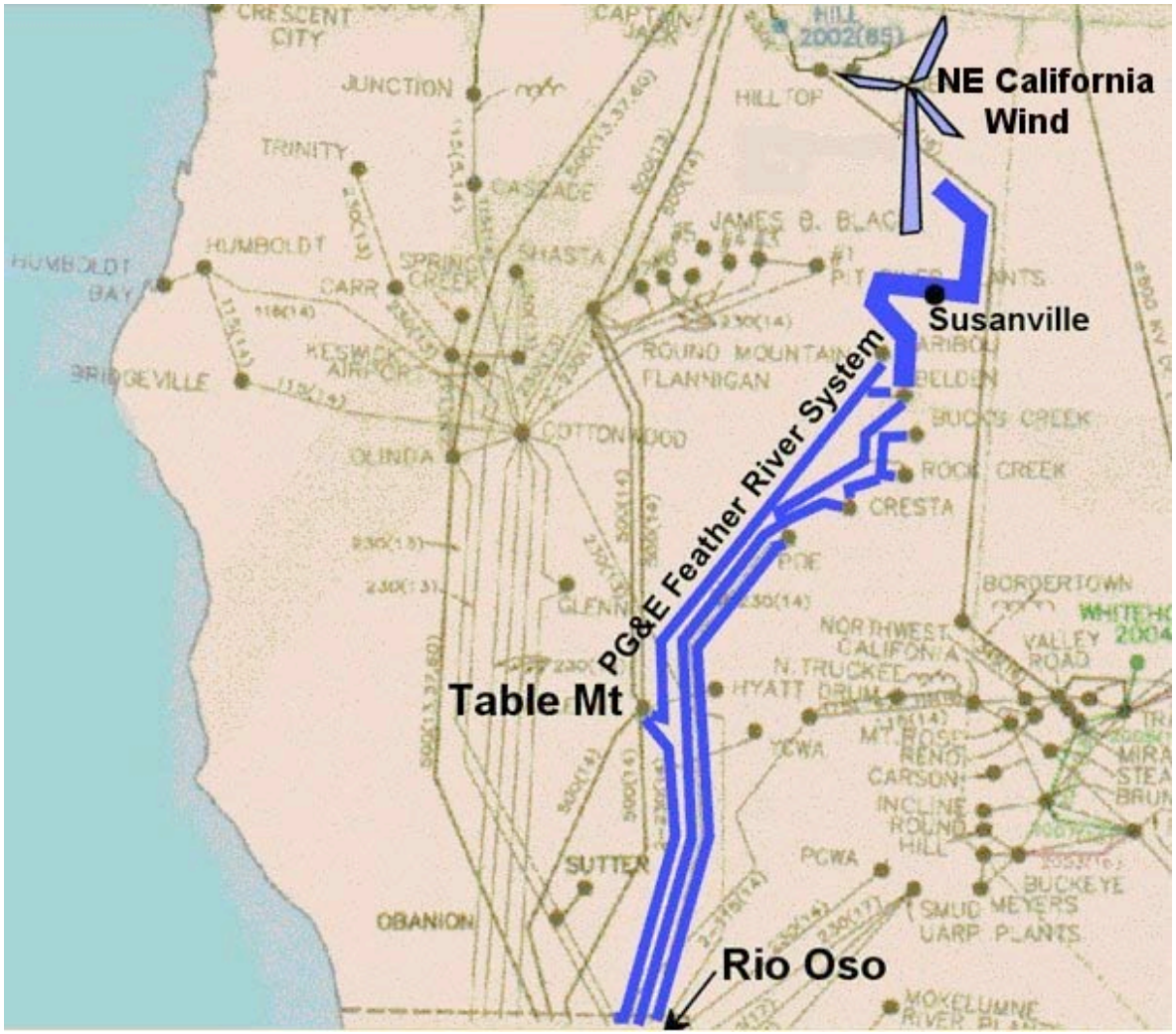
Long Term – Tap PDCI without connection to N. Nevada Power System - 1500 MW



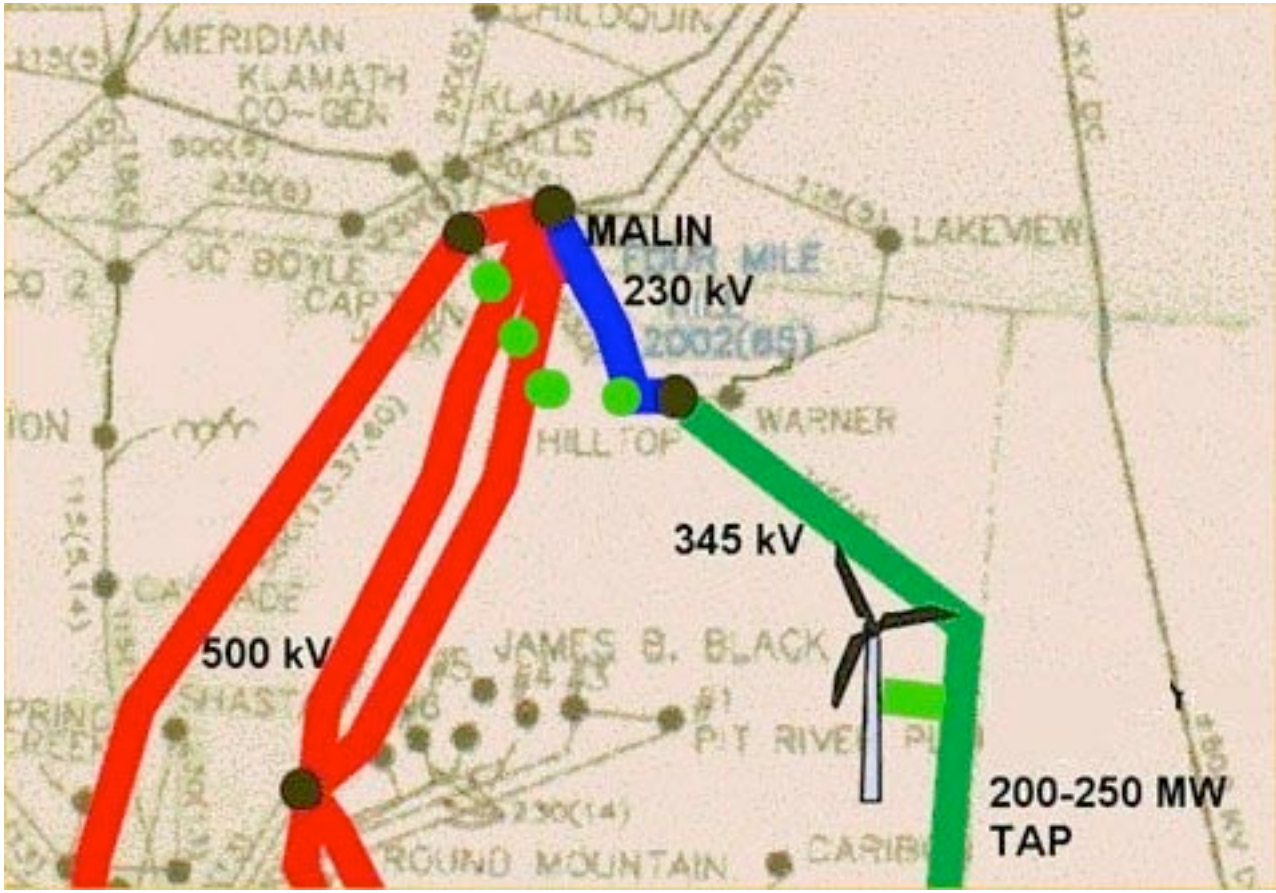
Long Term – Tap PDCI & Trans-Sierra Transmission Options 1500 to 3000 MW



Long Term – Trans-Sierra 230 kV ac Transmission - 200 MW



Extend/upgrade Bordertown – Alturas 345 kV line to Capt Jack - 200 MW



To increase Interconnection Capacity into California

Selected long term upgrades (beyond 2010)

Description	**Increased Capacity (MW)**	**Capital Cost M_{2005}$**	**$/kW**
Tap to PDCI (no connection to existing transmission	1500	235	157
Tap to PDCI plus Trans-Sierra 500 kV ac line	1500+	445	297-
Trans-Sierra 230 kV ac transmission	200	69	345
Extend/upgrade Bordertown – Alturas line to Capt Jack	200	72	360

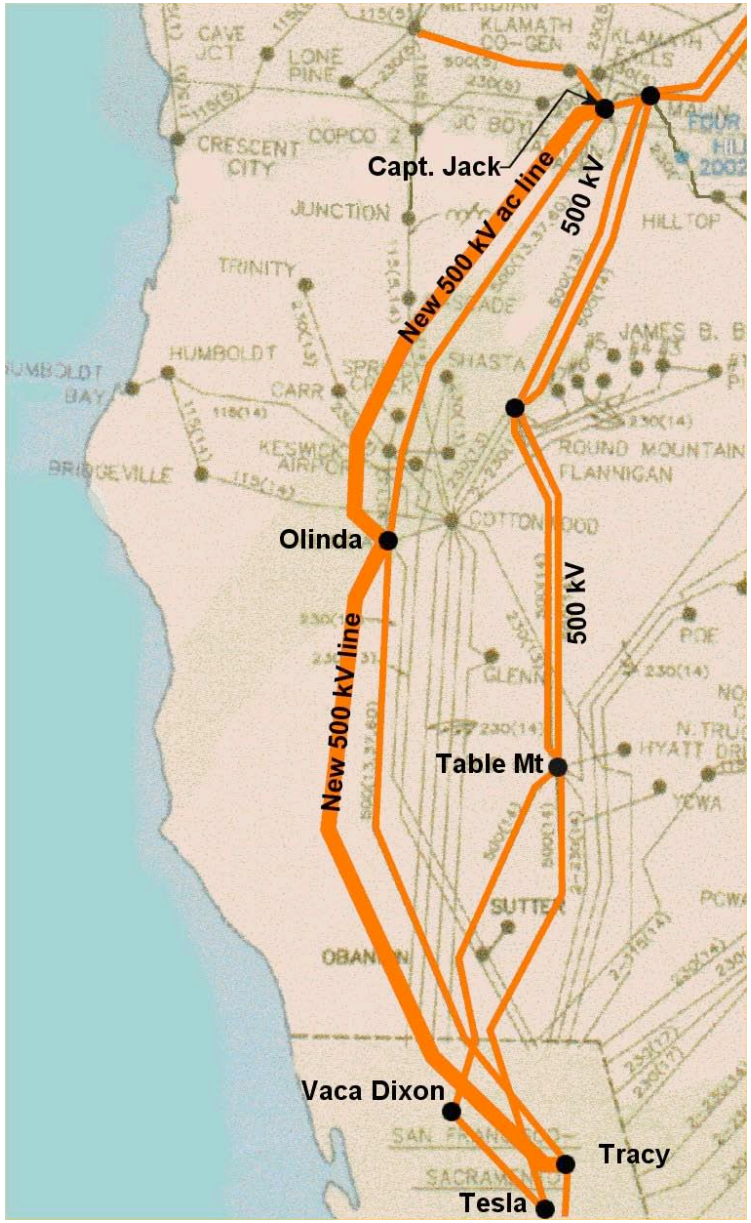
Increasing Interconnection Capacity into California Issues and Impacts

- Adding transmission capacity may create congestion elsewhere
- Renewable energy collector system may not be insignificant

Potential Development of Wind Power in Oregon for California Markets

There are several thousand MW of potential wind energy to be developed in Oregon.

This may require a 4th 500 kV transmission line for the Pacific HVAC Intertie



Additional Concepts for Further Consideration

- An existing 500 kV circuit from the Columbia River to Sacramento/Bay Area could be converted to dc for a transfer capacity of 3500 MW

- Segmenting northern California at COB, Donner Pass and Path 15 with back-to-back dc transmission may increase transmission capacities on these existing interconnections